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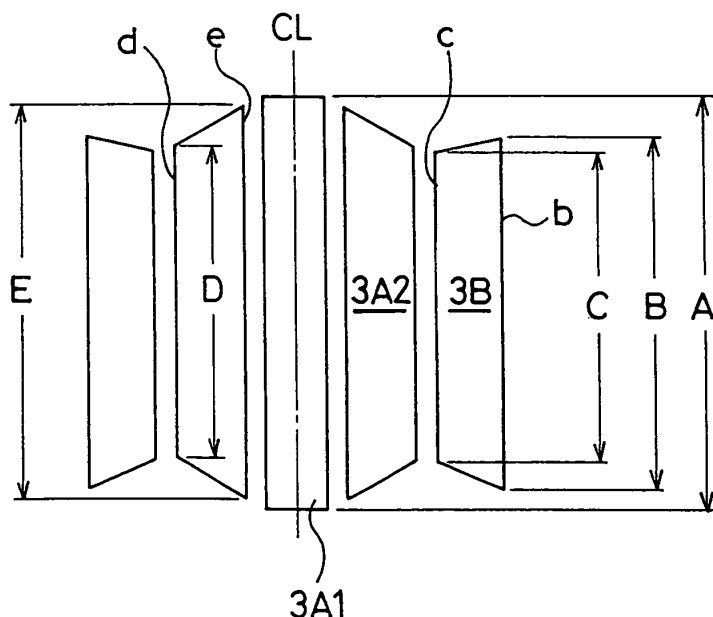
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(54) **Pneumatic tire**

(57) A pneumatic tire includes a tread surface having four main grooves extending in a circumferential direction of the tire. The four main grooves consist of two inner main grooves disposed on both sides of an equatorial plane of the tire and two outer main grooves disposed outwardly of the two inner main grooves. Three land portions extending in the tire circumferential direction are formed in a center region located between the two outer main grooves, and a land portion extending in the tire circumferential direction is formed in each of

shoulder regions located outwardly of the two outer main grooves. The ratio B/A of the ground contact length B of the outer edge of the land portion in the shoulder region to the ground contact length A of the central land portion of the three land portions in the center region is in the range of 0.80 to 0.95, and the ratio C/B of the ground contact length C of the inner edge of the land portion in the shoulder region to the ground contact length B of the outer edge thereof is in the range of 0.90 to 1.00.

Fig.2



EP 1 529 658 A1

Description

BACKGROUND OF THE INVENTION

5 **[0001]** The present invention relates to pneumatic tires, and more particularly, to a pneumatic tire which can improve irregular wear.

10 **[0002]** In general, pneumatic tires used for vehicles such as buses and trucks employ a rib pattern having ribs defined by main grooves extending in a circumferential direction of the tire in a tread surface thereof. These pneumatic tires have a problem of irregular wear such as shoulder wear that the outer edge portions of ribs located in the opposite shoulder regions of the tread surface wear earlier, and railway wear that wear grows along the edge portions on one side of the ribs, especially the inner edge portions of the ribs located in the shoulder regions. The growth of such irregular wear develops polygonal wear, which encourages vibration of the tire.

15 **[0003]** Conventionally, to solve the above problem, a pneumatic tire is disclosed in Unexamined Japanese Patent Application Publication No. 8-85308, which includes ribs having a specified ground contact length to thereby improve irregular wear.

[0004] However, the pneumatic tire to be particularly mounted on a steering wheel does not have a sufficient effect of preventing railway wear and shoulder wear, and further improvement is desired.

SUMMARY OF THE INVENTION

20 **[0005]** An object of the present invention is to provide a pneumatic tire in which both railway wear and shoulder wear can effectively be suppressed.

25 **[0006]** In order to achieve the above object, a pneumatic tire according to the present invention includes a tread surface having four main grooves extending in a circumferential direction of the tire, the four main grooves consisting of two inner main grooves disposed on both sides of an equatorial plane of the tire and two outer main grooves disposed outwardly of the two inner main grooves, three land portions extending in the tire circumferential direction being formed in a center region located between the two outer main grooves, a land portion extending in the tire circumferential direction being formed in each of shoulder regions located outwardly of the two outer main grooves, wherein the following relationships are fulfilled when the tread surface contacts with a ground:

$$0.80 \leq B/A \leq 0.95$$

$$0.90 \leq C/B \leq 1.00$$

where A is the ground contact length of the central land portion of the three land portions in the center region, B is the ground contact length of the outer edge of the land portion in the shoulder region and C is the ground contact length of the inner edge of the land portion in the shoulder region.

40 **[0007]** According to the present invention described above, the ground contact length A of the center land portion in the center region, and the ground contact length B of the outer edge and the ground contact length C of the inner edge of the land portion in the shoulder region have relationships specified as described above to thereby make the ground contact shape of the tread surface optimal for suppression of shoulder wear and railway wear created on the ribs in the shoulder regions, which allows for effective suppression of occurrence of the two wears. Therefore, railway wear resistance as well as shoulder wear resistance can be enhanced.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008]

50 FIG. 1 is a partial development view of a tread surface showing an embodiment of a pneumatic tire according to the present invention;

FIG. 2 is a view for schematically illustrating a ground contact shape of the tread surface of the pneumatic tire of the present invention;

55 FIG. 3 is a view for schematically illustrating a ground contact shape of a tread surface of the case where ribs in the shoulder regions have ground contact lengths longer than those in the center side;

FIG. 4 is a view for schematically illustrating a ground contact shape of a tread surface of the case where ribs in the shoulder regions have ground contact lengths shorter than those in the center side;

FIG. 5 is a view for schematically illustrating a ground contact shape of a tread surface of the case where the ground contact length of the inner edge of each rib in the shoulder region is longer than that of the outer edge thereof, and where the ground contact length of the outer edge of each of ribs on both sides in the center region is longer than that of the inner edge thereof; and

FIG. 6 is a view for schematically illustrating a ground contact shape of a tread surface of the case where the ground contact length of the inner edge of each rib in the shoulder region is shorter than that of the outer edge thereof, and where the ground contact length of the outer edge of each of ribs on both sides in the center region is shorter than that of the inner edge thereof.

DESCRIPTION OF THE PREFERRED EMBODIMENT

[0009] The embodiment of the present invention will be described in detail below with reference to the drawings.

[0010] Referring to Fig. 1, there is shown an embodiment of a pneumatic tire according to the present invention. A tread surface 1 has four main grooves 2 extending straight along a circumferential direction T of the tire. The four main grooves 2 include two inner main grooves 2B placed on both sides of an equatorial plane CL of the tire, and two outer main grooves 2A placed outwardly of the two inner main grooves 2B, and are symmetrically located with respect to the tire equatorial plane CL. These four main grooves 2 defines five ribs (land portions) 3 extending in the tire circumferential direction T in the tread surface 1.

[0011] Three ribs 3A are disposed in a center region 1A of the tread surface 1 located between the two outer main grooves 2A. The central rib 3A1 thereof is disposed on the tire equatorial plane CL, and the ribs 3A2 on both sides of the central rib are symmetrically placed with respect to the tire equatorial plane CL. One rib 3B is provided in each of two shoulder regions 1B located outwardly of the two outer main grooves 2A.

[0012] As shown in FIG. 2, when the tread surface 1 engages a road surface, the central rib 3A1 in the center region 1A and the ribs 3A in the shoulder regions 1B satisfy the following relationships:

$$0.80 \leq B/A \leq 0.95$$

$$0.90 \leq C/B \leq 1.00$$

where A is the ground contact length in millimeters of the central rib 3A1 on the tire equatorial plane CL, B is the ground contact length in millimeters of the outer edge b of the rib 3B and C is the ground contact length in millimeters of the inner edge c of the rib 3B

[0013] The ground contact length D in millimeters of the outer edge d of each of the ribs 3A2 on both sides in the center region 1A is equal to or shorter than the ground contact length E in millimeters of the inner edge e thereof. The ground contact length E of the inner edge e is equal to or shorter than the ground contact length A of the central rib 3A1, and is equal to or longer than the ground contact length B of the outer edge b of the rib 3B in the shoulder region 1B. The ground contact length D of the outer edge d of the rib 3A2 is equal to or longer than the ground contact length C of the inner edge c of the rib 3B.

[0014] The term "ground contact length of the rib" as used herein is the ground contact length of the rib measured when a tire contacts with a ground (road surface) under conditions such that the tire is mounted on a standard rim described in JATMA (JATMA YEAR BOOK 2003) and an air pressure and a load corresponding to the maximum load ability described therein are applied thereto.

[0015] The aforementioned ground contact shape (footprint) can be obtained, for example, by making the curvature radius of the center region 1A of the tread surface 1 properly greater than that of the shoulder region 1B, or by properly adjusting the groove wall angles of the main grooves 2.

[0016] The present inventor has found the following fact through an intense study about railway wear and shoulder wear which were problematic with heavy duty pneumatic tires to be mounted on a steering wheel, having a tread surface with the four main grooves.

[0017] It turned out that, as shown in FIG. 3, when the ground contact shape of a tread surface having five ribs R defined by the four main grooves was formed such that ribs R1 in the shoulder regions had ground contact lengths longer than those of the ribs in the center side, a high tendency to create shoulder wear was shown, and that, as shown in FIG. 4, when the ground contact shape of the tread surface was formed such that ribs R1 in the shoulder regions had ground contact lengths shorter than those of the ribs in the center side, a low tendency to create shoulder wear was shown.

[0018] Also, it turned out that, as shown in FIG. 5, when the ground contact length of the inner edge of a rib R2b in the shoulder region was longer than the ground contact length of the outer edge thereof, railway wear occurred in a

shaded section of the rib R2b, and when the ground contact length of the outer edge of a rib R2a in the center region was longer than the ground contact length of the inner edge thereof, railway wear occurred in a shaded section of the rib R2a.

[0019] Further, it turned out that, as shown in FIG. 6, when the ground contact length of the inner edge of a rib R2b in the shoulder region was shorter than the ground contact length of the outer edge thereof, the rib R2b had a low tendency to create railway wear, and when the ground contact length of the outer edge of a rib R2a in the center region was shorter than the ground contact length of the inner edge thereof, the rib R2a had a low tendency to create railway wear.

[0020] Therefore, in the present invention, the relationships between the ground contact lengths of the ribs 3 defined by the four main grooves 2 are specified as described above. Formation of the ground contact shape having the relationships, specified as mentioned above, between the ground contact length A of the central rib 3A1 located on the tire equatorial plane CL in the center region 1A, and the ground contact lengths B and C of each of the ribs 3B located in the shoulder regions 1B, allows the ground contact shape of the tread surface 1 to be optimized for restriction of shoulder wear and railway wear created on the ribs 3B in the shoulder regions 1B to thereby effectively suppress occurrence of the two wears. Accordingly, railway wear as well as shoulder wear can be improved.

[0021] If the ratio B/A is less than 0.80, it is not preferable because the central rib 3A1 is susceptible to occurrence of irregular wear called rib punch. If the ratio B/A is greater than 0.95, it is difficult to effectively suppress shoulder wear.

[0022] If the ratio C/B is less than 0.9, or is greater than 1.00, railway wear can not effectively be suppressed.

[0023] The ground contact lengths D and E of each of the ribs 3A2 on both sides in the center region 1A are specified as described above, railway wear created along the outer edge d of each of the ribs 3A2 can effectively be suppressed without creating a problem of other irregular wear.

[0024] In particular, the present invention is preferably applicable to heavy duty pneumatic tires to be mounted on a steering wheel, but is not limited thereto.

EXAMPLE

[0025] Prepared, respectively, were tires 1 to 5 according to the present invention, comparative tires 1 and 2 and a conventional tire having a tire size of 295/75R22.5 and an arrangement shown in FIG. 1, each tire except the conventional tire having the ratio B/A of the ground contact length B of the outer edge of the rib in the shoulder region to the ground contact length A of the central rib in the center region, and the ratio C/B of the ground contact length C of the inner edge of the rib in the shoulder region to the ground contact length B of the outer edge thereof shown in Table 1, the conventional tire having ribs having the same ground contact length.

[0026] In the present invention tires and the comparative tires, the ground contact length D of the outer edge of each of the ribs on both sides in the center region, and the ground contact length E of the inner edge thereof had the following relationships:

$$D < E$$

$$E < A$$

$$E > B$$

$$D > C$$

[0027] Each test tire was mounted on a 8.25 × 22.5 sized rim, an air pressure of 760 kPa was applied thereto, and the resulting tire was attached to a truck with a load of 20 tons as a front wheel. Evaluation tests for shoulder wear and railway wear were conducted in accordance with the following test methods. The results shown in Table 1 were obtained.

Shoulder Wear

[0028] The wear amount of the central rib in the center region of each test tire and the wear amount of the outer edge of each of the ribs in the shoulder regions thereof were measured after traveling of 60,000 miles (96,000 km) along a public road, and shoulder wear of each test tire was evaluated from the difference between the two wear amounts. The evaluation results of the test tires were represented by the index on the basis of the conventional tire

as 100. The greater the index value is, the less the shoulder wear occurs and the better the shoulder wear resistance is.

Railway Wear

[0029] The wear amount of the inner edge of each of the ribs in the shoulder regions of each test tire was measured after the above traveling of 60, 000 miles (96, 000 km), and the evaluation results were represented by the index on the basis of the conventional tire as 100. The greater the index value is, the less the railway wear occurs and the better the railway wear resistance is.

Table 1

	B/A	C/B	Shoulder Wear	Railway Wear
Conventional Tire	-	-	100	100
Comparative Tire 1	1.00	1.05	105	90
Present Invention Tire 1	0.95	1.00	110	105
Present Invention Tire 2	0.90	0.95	115	110
Present Invention Tire 3	0.85	0.90	120	115
Present Invention Tire 4	0.80	0.90	125	120
Comparative Tire 2	0.75	0.80	rib punch	125

[0030] As can be seen from Table 1, the tires according to the present invention can effectively suppress shoulder wear and railway wear, and improve shoulder wear resistance as well as railway wear resistance.

Claims

1. Apneumatic tire having a tread surface having four main grooves extending in a circumferential direction of the tire, the four main grooves consisting of two inner main grooves disposed on both sides of an equatorial plane of the tire and two outer main grooves disposed outwardly of the two inner main grooves, three land portions extending in the tire circumferential direction being formed in a center region located between the two outer main grooves, a land portion extending in the tire circumferential direction being formed in each of shoulder regions located outwardly of the two outer main grooves, wherein the following relationships are fulfilled when the tread surface contacts with a ground:

$$0.80 \leq B/A \leq 0.95$$

$$0.90 \leq C/B \leq 1.00$$

where A is the ground contact length of the central land portion of the three land portions in the center region, B is the ground contact length of the outer edge of the land portion in the shoulder region and C is the ground contact length of the inner edge of the land portion in the shoulder region.

2. A pneumatic tire according to claim 1, wherein the ground contact length D of the outer edge of each of the land portions of the three land portions on both sides of the central land portion in the center region is equal to or greater than the ground contact length E of the inner edge thereof.

3. A pneumatic tire according to claim 2, wherein the ground contact length E of the outer edge of each of the land portions on both sides in the center region is equal to or less than the ground contact length A of the central land portion, and is equal to or greater than the ground contact length B of the outer edge of the land portion in the shoulder region.

4. A pneumatic tire according to any one of claims 2 and 3, wherein the ground contact length D of the outer edge of each of the land portions on both sides in the center region is equal to or greater than the ground contact length

EP 1 529 658 A1

C of the inner edge of the land portion in the shoulder region.

5 5. A pneumatic tire according to any one of claims 1 to 4, wherein the four main grooves are symmetrically disposed with respect to the tire equatorial plane.

6. A pneumatic tire according to any one of claims 1 to 5, therein the four main grooves extend straight in the tire circumferential direction.

10 7. A pneumatic tire according to any one of claims 1 to 6, wherein the pneumatic tire is a heavy duty pneumatic tire.

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Fig.1

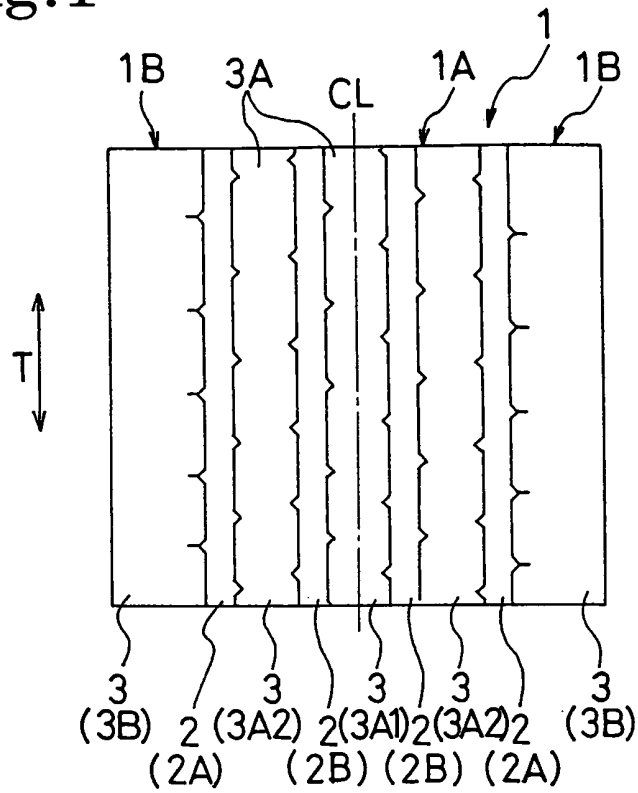


Fig.2

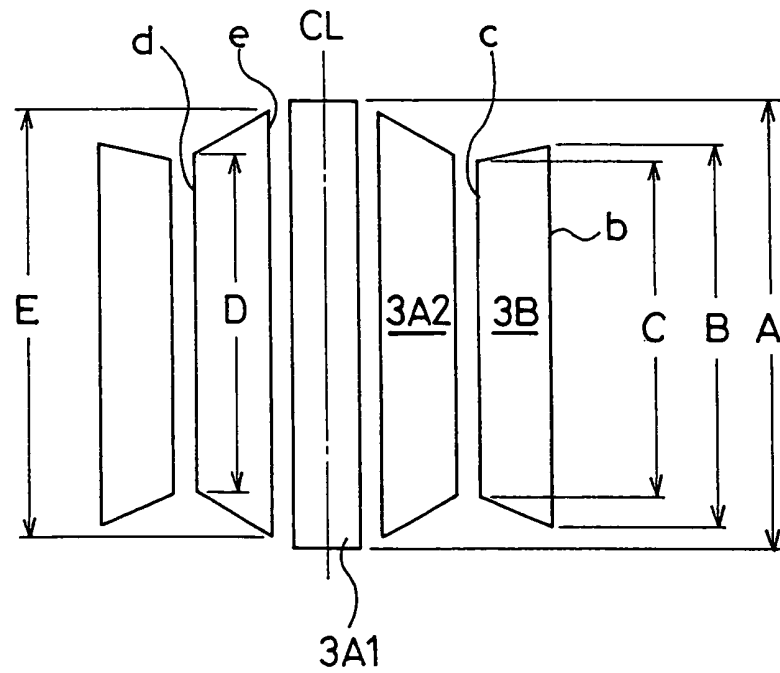


Fig.3

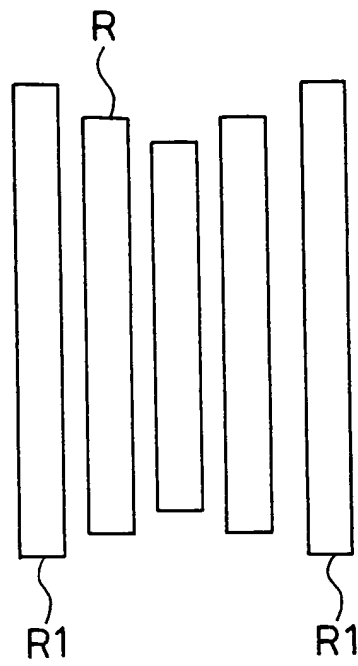


Fig.4

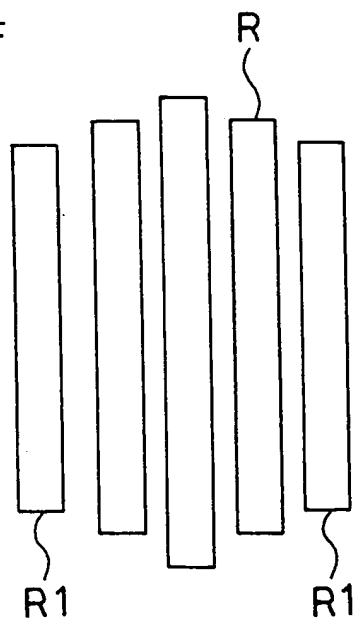


Fig.5

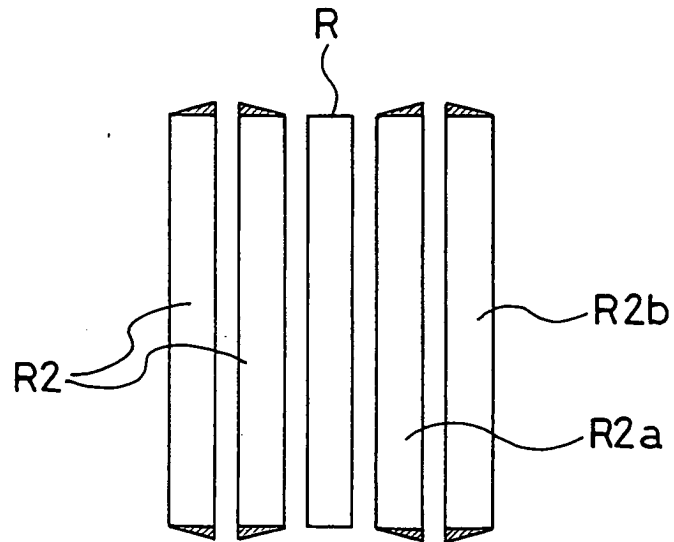
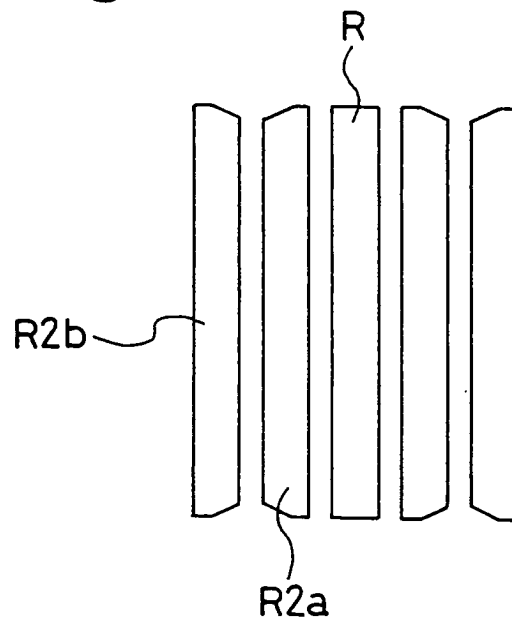


Fig.6





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EUROPEAN SEARCH REPORT

Application Number
EP 04 02 5999

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X	WO 03/035413 A1 (SUMITOMO RUBBER INDUSTRIES, LTD; MARUOKA, KIYOTO; NISHI, MINORU; YAMAH) 1 May 2003 (2003-05-01) * figure 4 *	1,3-7	B60C11/03
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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 2 February 2005	Examiner Vessi�re, P
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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EP 04 02 5999

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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